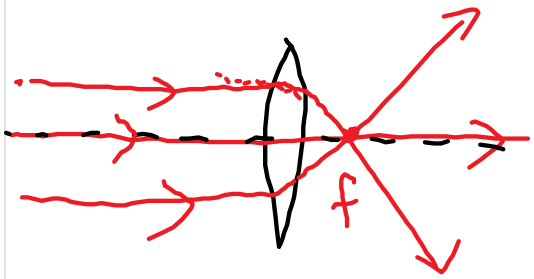
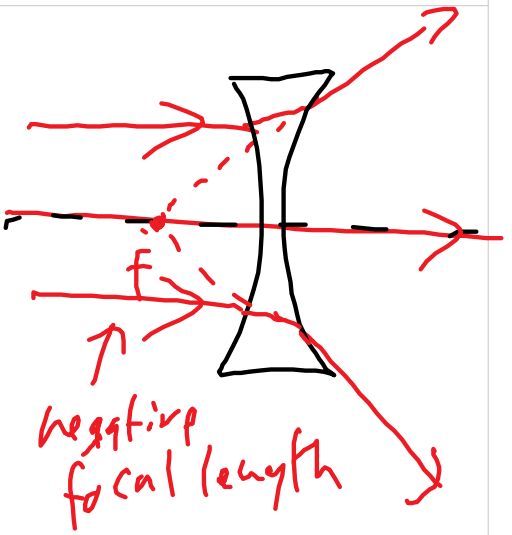
Lenses

Convex	Concave
Fat in the middle	Curved in
Far - inverted near- upright and enlarged (like - concave mirror)	Smaller and upright (like a convex mirror)
Draw light rays	





lens maker's equation

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \qquad m = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

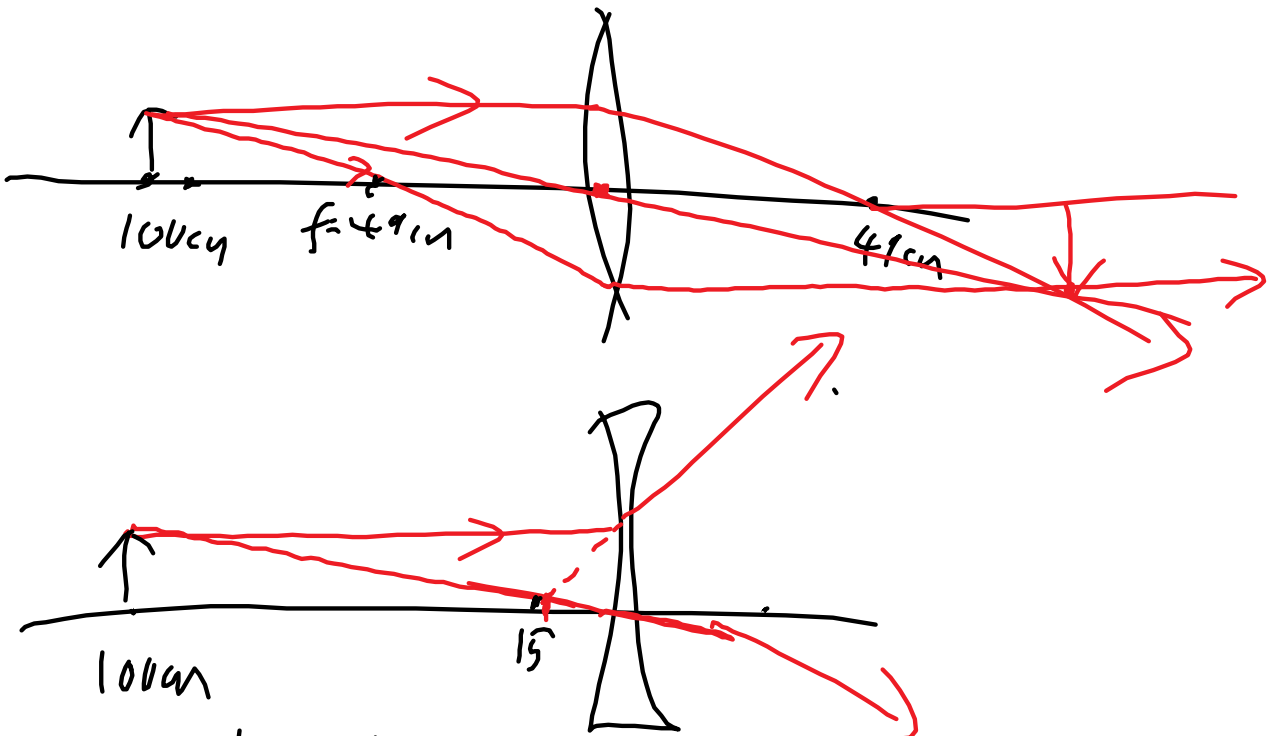
e.g. The filament of a light bulb is 8.5cm. $f = 49\,cm$. Where is the image of the

filament if it is 1.00 m away from the lens? What is the size of the image?

Solve again for a concave lens $f = -15\,cm$

i) using a ray diagram to scale

ii) using equations



100cm

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

$\frac{1}{49cm} = \frac{1}{100cm} + \frac{1}{d_i}$

$d_i = 100cm$

$\frac{h_i}{h_o} = \frac{-d_i}{d_o} = \frac{-100}{100}$

$m = -1$

$h_i = -h_o$

$h_i = -8.5cm$

15

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

$\frac{1}{-15cm} = \frac{1}{100} + \frac{1}{d_i}$

$\frac{-100}{1500} - \frac{15}{15cm} = \frac{1}{d_i}$

$d_i = \frac{-1500}{115}$

$d_i = -13cm$

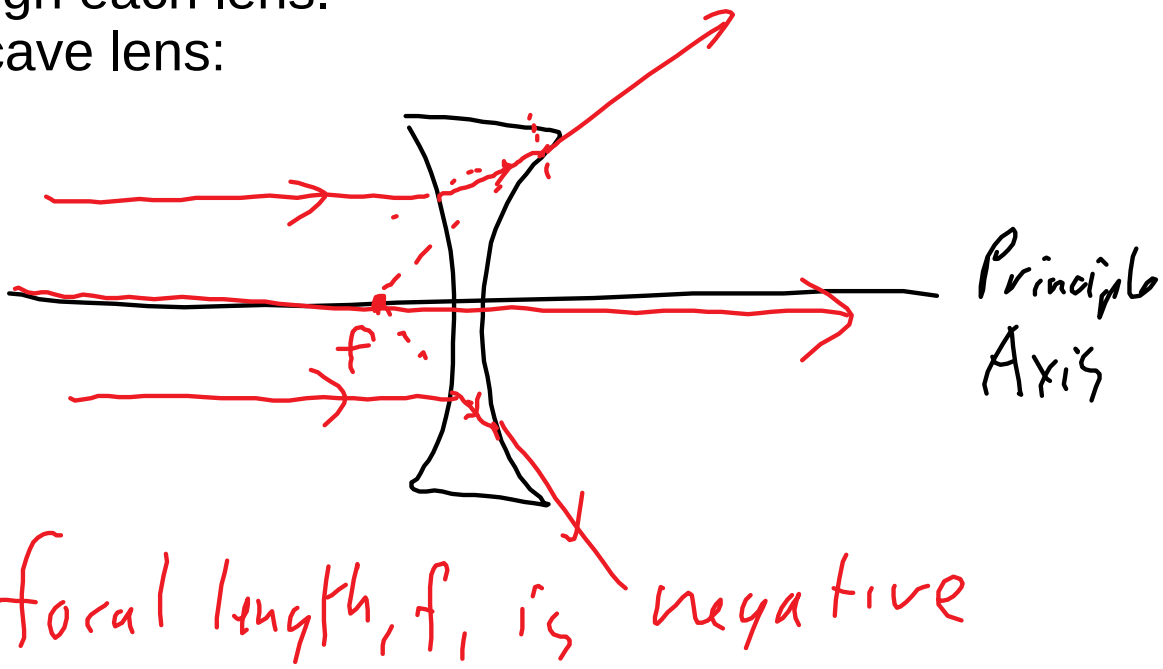
Test:

Lenses
What do you see through:
Concave lens:
Upright, smaller image

Like a convex mirror

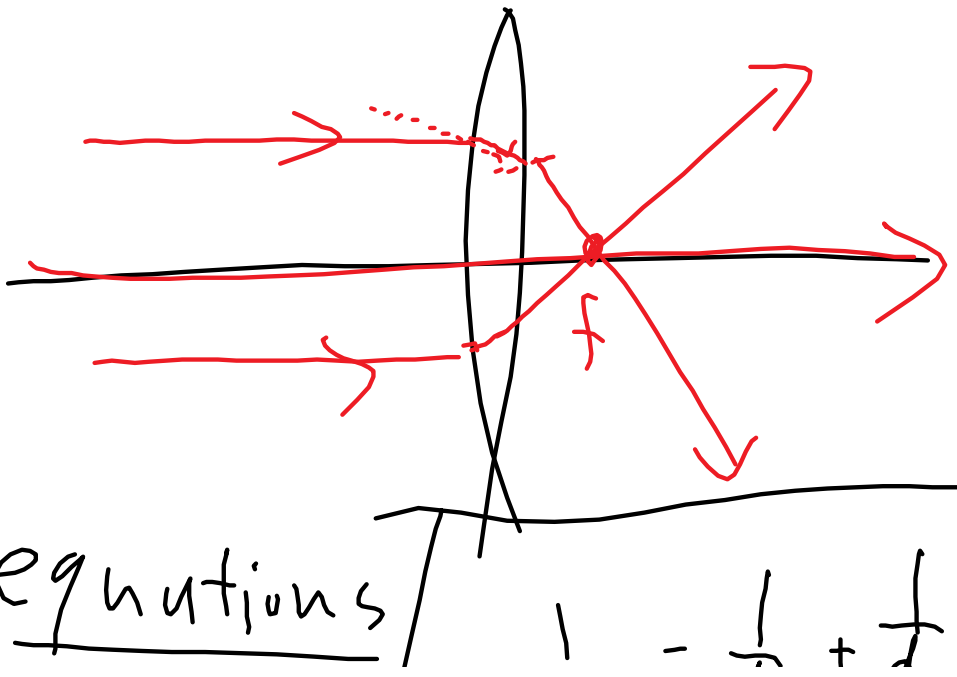
Convex lens:
Far - image is upside down
Close - image is upright and enlarged
Like a concave mirror

Predict 3 light rays parallel to principle axis going through each lens.
Concave lens:



focal length, f, is negative

Convex lens



equations $1 = \frac{1}{i} + \frac{1}{d}$

Equations

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

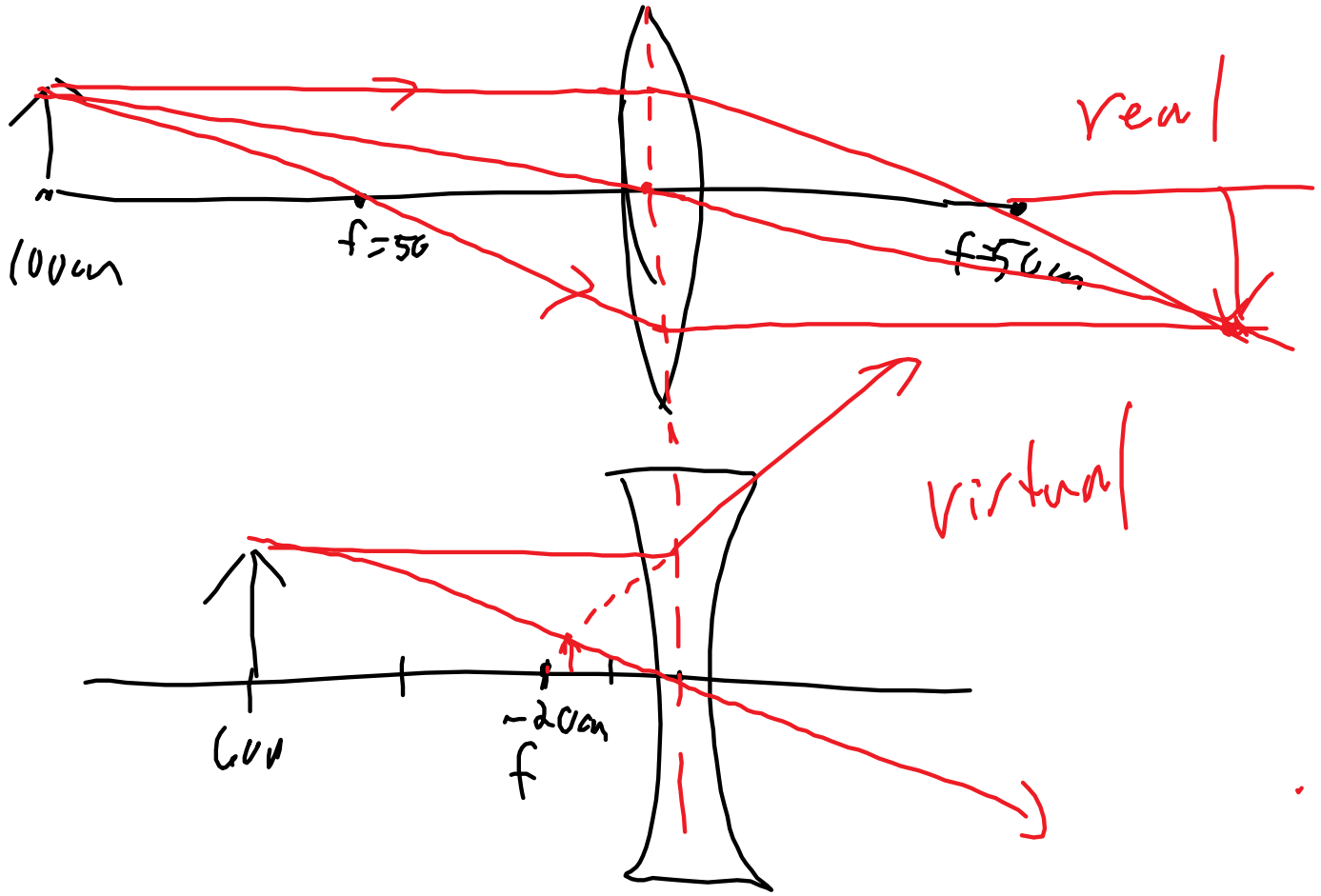
$$M = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

A 8.0 cm filament of the light bulb shines light through a lens. Determine the magnification, type, size and location of the image using a scale ray diagram and equations if

a) The lens is convex, focal length 50.0 cm with the filament 100.0 cm away from the lens.
b) The lens is concave, focal length -20.0 cm, and the object is 60.0 cm away from the lens.

Steps:

1. Draw Principle axis
2. Draw lens
3. Locate focal point
4. Draw the object as an arrow off the PA
5. Draw a ray from the top of the arrow parallel to the principle axis.
6. Draw a ray to/from the focal point refracts parallel to the principle axis OR dray a ray through the centre of the lens straight through.
7. Where the rays meet, you have your image. (or seem to meet)



Convex

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{50} = \frac{1}{100} + \frac{1}{d_i}$$

$$\frac{2}{100} - \frac{1}{100} + \frac{1}{d_i}$$

$$\boxed{d_i = 100\ \text{cm}}$$

$$m = \frac{h_i}{h_o} = \frac{-d_i}{d_o} = \frac{-100}{100} = \underline{-1}$$

$h_1 = -h_0$